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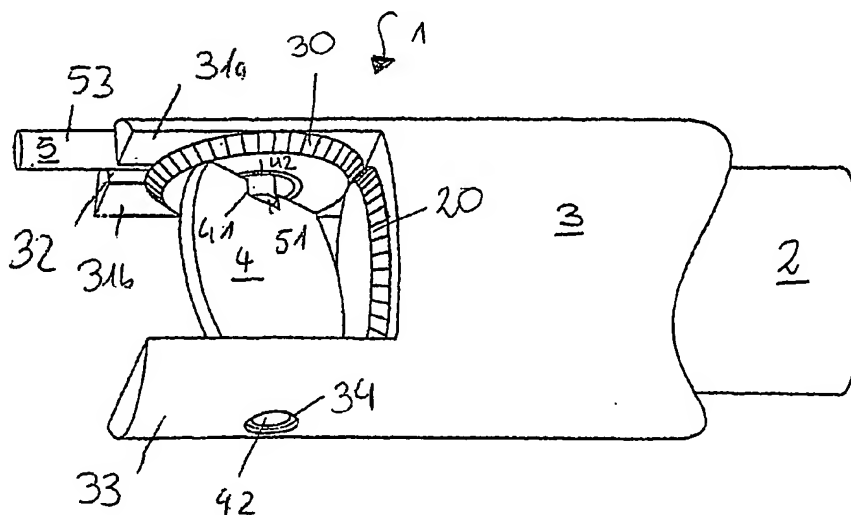
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ance Notes on Codes and Abbreviations" appearing at the begin-
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(54) Title: SAMPLE DEVICE WITH TURNTABLE



(57) Abstract: The invention refers to a sample device to be inserted inside an external tube, having a substantially circular cross-section, and carrying a substantially circular plate as part of a turntable (4) to be rotated within the external tube (3) around two substantially orthogonal axes. Two substantially coaxial tubes (3, 2), with the turntable being supported by the outer tube (3), and two meshing gears (30, 20), with the first gear (20) being connected to the inner tube (2) and the second gear (30) being connected to the turntable (4), and/or a special cable guide (5) being connected with its first end with the turntable (4) and its second end, being substantially perpendicular to the first end, with the supporting means, with the inner tube (2), the outer tube (3) and/or the cable guide (5) being connected with a driving unit, are provided for maximizing the surface of the plate to be rotated within the external tube.

WO 2005/064225 A1

Sample device with turntable

Description

The present invention refers to a sample device with a turntable.

Such a sample device is, for example, described in the not pre-published international patent application PCT/EP02/07226 of the applicant as part of a magnetic calibration device.

It is an object of the present invention to provide a sample device with a turntable which has a maximized surface fitting inside an external tube with a substantial circular cross-section.

The object of the invention is achieved by a sample device suited to be inserted inside an external tube with a radius r_{\max} , comprising a turntable with a substantially circular plate having a radius r_{table} , a rotator for rotating said turntable around two substantially orthogonal axes, two substantially coaxial tubes, the turntable being supported by the outer tube, and two meshing gears, the first gear being connected to the inner tube and the second gear being connected to the turntable, the first gear having a radius r_{gear1} , the second gear having a radius r_{gear2} and the inner tube having a radius $r_{\text{inner tube}}$ such that $r_{\text{table}} \leq r_{\max} - d \sqrt{1 + \frac{1}{n^2}}$, with d being the gear thickness and n being the gear transmission ratio.

It is preferred that the sample device comprises in addition at least one first cable guide having a first end connected to the turntable and the second end connected to a cable support.

With the invention it is proposed that the cable support is guided by the outer tube and/or connected to at least one synchronizing means and/or at least one first driving unit.

The object of the invention is also achieved by another sample device suited to be inserted inside an external tube with a radius r_{\max} , comprising a turntable with a substantially circular plate having a radius r_{table} , a rotator for rotating said turntable around two substantially orthogonal axes, at least one supporting means for supporting the turntable, and at least one first

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cable guide having a first end connected to the turntable and the second end connected to a cable support, said cable support being connected to at least one first driving unit.

It is preferred that the supporting means comprises an outer tube.

According to the invention an inner tube is coaxially arranged within the outer tube, preferably at least one gear being arranged between the inner and the outer tube.

In one embodiment of the invention with the cable support being connected to at least one first driving unit, the sample device is characterized by two meshing gears, the first gear being connected to the inner tube and the second gear being connected to the turntable, preferably the first gear having a radius r_{gear1} , the second gear having a radius r_{gear2} and the inner tube having a radius $r_{\text{inner tube}}$ such that $r_{\text{table}} \leq r_{\text{max}} - d \sqrt{1 + \frac{1}{n^2}}$, with d being the gear thickness and n being the gear transmission ratio.

It is proposed with the invention that the cable support is guided by the supporting means, in particular the outer tube, and/or connected to at least one synchronizing means.

According to the invention it is further proposed that the gear thickness d is the thickness of the first or second gear, preferably corresponding to the thickness of the inner tube.

Also proposed is that the gear transmission ratio n corresponds to $r_{\text{inner tube}} / r_{\text{gear}}$, with $r_{\text{gear}} = r_{\text{gear1}}$ or r_{gear2} , preferably $r_{\text{gear1}} = r_{\text{gear2}}$ and/or $r_{\text{gear1}} = r_{\text{inner tube}}$.

In a preferred embodiment the first cable guide comprises at least one first bellow and/or spring, preferably between the two ends, in particular the first end being arranged substantially perpendicular to the second end.

With the invention it is proposed that the first bellow and/or spring is guided by a support, preferably connected with the outer tube.

Also proposed with the invention is that the cable support is provided with at least one external second bellow and/or spring.

Further the invention proposes that the inner tube and/or the outer tube is/are connected to at least one second driving unit.

In a preferred embodiment of the invention the sample device is characterized in that the rotator comprises the inner tube, the outer tube and/or the cable guide connected to at least one driving unit, in particular the first and/or second driving unit(s).

It is proposed that the driving unit, in particular the first and/or second driving unit(s), comprises at least one stepper engine and/or at least one worm wheel and/or at least one gear.

Also proposed is that the outer tube is provided with at least one axial extension for supporting the turntable.

It is preferred that the extension is provided with at least one recess for carrying at least one first bearing and/or the cable guide, the turntable, in particular a rotation pin connected to the substantially circular plate, and/or the cable guide is/are mounted within at least one first bearing.

With the invention it is also proposed that the outer tube is provided with two opposite extensions for carrying at least two rotation pins.

The sample device of the invention can also comprise a second bearing between the inner tube and the outer tube.

It is possible that the first and second gears are formed as tooth or roll gears, and/or the first and second gears are formed as straight and/or conical gears.

Also proposed with the invention is that the first gear is machined on or mounted on the inner tube, and/or the second gear is machined on or mounted on the turntable, in particular a support extending substantially perpendicular to the plate and/or substantially coaxially to at least one rotation pin.

According to the invention it is proposed that the inner tube is made from carbon fiber and/or provided with chrome plated teeth, and/or the turntable is made from carbon fiber and/or provided with chrome plated teeth.

Also proposed is that the first and/or second gear is/are made of acetal.

Still further, with the invention it is proposed that the first and/or second bellow is/are made out of rubber, and/or the first and/or second spring is/are made out of non magnetic metal, preferably comprising copper, like copper beryllium, or plastic.

It is proposed that the sample device comprises at least one thermal isolation layer between the external tube and the outer tube, the thermal isolation layer preferably being evacuated.

The sample device of the invention can also comprise means for blowing a gas, in particular conditioned air, into the external tube, preferably the gas entering into the inner or outer tube and exiting the outer or inner tube.

It is preferred that the sample device also comprises a control unit connected to the first and/or second driving unit.

In yet another aspect of the invention at least one test object, at least one sample, at least one sensor, at least one mirror, at least one camera, at least one tool and/or at least one electronic device is/are, preferably detachably, attached to the turntable, in particular at least one side of the substantially circular plate, and/or connected with the control unit.

It is also proposed that the control unit is arranged remote from the turntable, preferably at least one cable, in particular guided at least partially within the first cable guide, being provided between the control unit and the turntable.

Still further, at least one second cable guide, preferably connected to the second end of the first cable guide, in particular being substantially flat and/or flexible, is proposed.

In one embodiment of the invention the sensor comprises at least one coil and/or at least one magnetic sensor, in particular for providing a magnetic calibration device.

In another embodiment of the invention the sample device comprises a source for emitting, preferably electromagnetic, radiation, in particular comprising a laser and/or a visible light source.

In this respect it is preferred that the radiation is guided to the turntable, in particular to the mirror and/or camera, preferably within the inner tube, in particular via at least one glass and/or fiber-optic light guide or waveguide.

Finally, the sample device of the invention can be characterized in that the amount of turns of the inner tube differs from the amount of the turns of the outer tube by one turn within one cycle, in particular measuring or calibration cycle.

With the invention two approaches for optimizing the dimensions of a sample device to be inserted inside an external tube, having a substantially circular cross-section, with respect to the surface of a substantially circular plate of a turntable to be rotated within said external tube around two substantially orthogonal axes are given.

According to one alternative, two substantially coaxial tubes, with the turntable being supported by the outer tube, preferably by a support directly milled into the outer tube, and two meshing gears, the first gear being connected to the inner tube and the second gear being connected to the turntable, are provided with the radius of the plate of the turntable being smaller than the radius of the external tube by an amount of only $\sqrt{(1+1/n^2)}$ times the gear thickness, in which n is the transmission ratio. The first gear can be machined on or mounted on the inner tube. In particular in case the first gear is machined on the inner tube, the inner tube should be as thin as possible in order to provide a large as possible rotating surface of the turntable plate. Therefore, straight gears might be advantageously. The inner tube can be made from carbon fiber with chrome plated teeth at the driving to avoid wear with respect to a normal gear.

As a second alternative, the object of the invention is solved by the employment of a special cable guide being connected with its first end with the turntable and its second end with a supporting means which is in turn connected to a driving unit such that the turntable is driven via the cable guide.

A cable guide, in particular as the one used with the second alternative, can also be used in case of the employment of two substantially coaxial tubes in line with the first alternative. Anyhow, it is advantageously to have at least one bellow or spring provided between the two ends of the cable guide, one being connected to the turntable and the other being connected to a cable support. The bellow or spring forces the two ends of the cable guide to rotate at the

same speed. This prevents the cable guided within the cable guide from winding up. If necessary, the bellow or spring can be guided by an additional support, in particular attached to the outer tube. Further, the cable support can, in particular in case of the usage of two substantially coaxial tubes, be synchronized to the rotation of said tubes from the outside to get less vibrations. In addition, the cable support can be prevented from rotation by an external bellow or spring.

The two driving tubes with the turntable can be put inside an external tube with a diameter of a few millimeters more than that of the outer driving tube for thermal isolation.

To save space, the return cable, connected to the turntable and partially guided within the cable guide, can be passed as flat cables or flex cables.

To keep a sample, test object or the like on the turntable at a constant temperature, conditioned air can be blown in one driving tube for leaving via the other driving tube.

The sample device according to the invention can be used in a huge amount of different applications.

One of said applications is within a magnetic calibration device. In this case, on one side of the turntable plate there can be provided three coils and the respective electronics and on the other side thereof the object to be tested or rather calibrated. Sample coils with only one adc and tripled sampling frequency can be used to gain further space. Also special coils, wound around a central point, with or without a Hall sensor inside, can be used. The diameter/height ratio of the coils can be chosen to get the best approximation of a point-like measurement. Chips to be used, in particular bare chips, can be directly bonded on a pc-board to gain further space. During measurement a normalization integrated coil signal - $\sqrt{B_x^2 + B_y^2 + B_z^2} = 1$ with B_x , B_y and B_z being the three spatial components of a magnetic field - can be corrected regarding non-orthogonality, self induction, offset, start position and/or bend width of electronics.

Coils can also be used to obtain the absolute value of the magnetic field to replace NMR measurements.

A further example of an application for a sample device of the invention is a directable borescope, namely a device for inspections through tiny holes. In this case, a normal fiber-optic borescope can be placed within the inner tube and a mirror can be placed on the turntable.

Also a laser pointer can be provided with a sample device of the invention, laser light shining through the inner tube onto a mirror on the turntable.

Another application of the sample device of the invention could be in connection with a camera, in particular a mini tv-camera, on the turntable. With this application it is in particular recommendable to only have one extension of the outer tube.

Still further, the sample device of the invention could be used within a manipulator which can pass through tiny holes or tubes. In this case for example a tool can be placed on the turntable. In case higher forces are necessary, larger gears can be employed within the sample device.

Of course, many other applications for a sample device of the invention are given.

The invention, together with further objects and advantages, may be best understood, by example, with reference to the following description of one embodiment taken together with the accompanying schematic drawings, in which

fig. 1 is a perspective view of a part of a sample device with a turntable of the invention;

fig. 2 is a cross-section taken parallel to a gear on an inner tube of the sample device of fig. 1 with the turntable being arranged parallel to said gear; and

fig. 3 is a perspective view as fig 1 showing internal parts in phantom.

According to fig. 1 a sample device 1 of the invention comprises an inner tube 2 arranged coaxially within an outer tube 3. A turntable 4 and a cable guide 5 are also provided.

On the inner tube 2 a first gear 20 is milled, whereas a second gear 30 is connected with the turntable 4. For that purpose the outer tube 3 is provided with two first extensions 31a, 31b with a recess 32 for carrying a rotation pin 42 within a bearing 63 and a second extension 33 with a recess 34 to carrying a second rotation pin 43 within a bearing 62, as can be best seen in fig. 2 and 3.

Both rotation pins 42, 43 are part of the turntable 4 and rigidly connected with a substantial circular plate 40 having at least one recess 41 next to the cable guide 5. In addition, the turntable 4 comprises a support 44 rigidly connected to one of said rotation pins 42 and being milled with the second gear 30 meshing in the gear 20 on the inner tube 2.

The cable guide 5 comprises a guiding tube 51 coaxially extending within the rotation pin 42 and being connected with a guiding bellow 52 which, in turn, being connected to an additional guiding tube 53 extending substantially perpendicular to the first guiding tube 51, as can be best seen in fig 3. The first guiding tube 51 opens to the plate 40 within its recess 41 to facilitate entering of not shown cables from a not shown sample or the like mounted on the plate 40 into the cable guide 5.

A further gear 61 is provided between the two tubes 2, 3.

In order to maximize the surface of the plate 40 within an external tube 10, into which the sample device 1 is inserted, see fig. 2, the inner tube 2 has to be as thin as possible, as the radius of the turntable 4 or rather its plate 40 has to be smaller than the radius of the outer tube 3 by an amount of only $\sqrt{(1+1/n^2)}$ times the gear thickness with n being the transmission ratio.

The plate 40 of the turntable 4 can take any orientation in space by choosing the right position of the two tubes 2, 3. A rotation of the inner tube 2 via a not shown driving unit around its longitudinal axis A1 in the direction R1 will lead to a rotation of the plate 40 in a direction R2 around an axis A2 being substantially perpendicular to the axis A1, whereas a rotation of the outer tube 3 via a not shown driving unit around its longitudinal axis A1 in the direction R1 will lead to a rotation of the plate 40 around the axis A1. Also a rotation of the guiding tube 53 around its longitudinal axis A3 in the direction R3 will lead to a rotation of the plate 40 around the axis A2, whereas a rotation of the guiding tube 53 around the axis A1 will lead to a rotation of the plate 40 around the axis A1. The rotation of the guiding tube 53 can also be driven by a not shown driving unit.

Although modifications and changes may be suggested by those skilled in the art, it is the intention of the application to embody within the patent warranted hereon all changes and modification as reasonably and probably within the scope of this contribution to the art. The features of the present invention which are believed to be novel are set forth in detail in the appended claims. The features disclosed in the description, the figures as well as the claims

could be essential alone or in every combination for the realization of the invention in its different embodiments.

Reference sign list

1	sample device
2	inner tube
3	outer tube
4	turntable
5	cable guide
10	external tube
20	gear
30	gear
31a, 31b	extension
32	recess
33	extension
34	recess
40	plate
41	recess
42	rotation pin
43	rotation pin
44	support
51	guiding tube
52	guiding bellow
53	guiding tube
61	bearing
62	bearing
63	bearing
A1	rotation axis
A2	rotation axis
A3	rotation axis
R1	rotation direction
R2	rotation direction
R3	rotation direction

Claims

1. Sample device (1) suited to be inserted inside an external tube (10) with a radius r_{\max} , comprising
 - a turntable (4) with a substantially circular plate (40) having a radius r_{table} ,
 - a rotator for rotating said turntable (4) around two substantially orthogonal axes (11, 12),
 - two substantially coaxial tubes (2, 3), the turntable (4) being supported by the outer tube (3), and
 - two meshing gears (20, 30), the first gear (20) being connected to the inner tube (2) and the second gear (30) being connected to the turntable (4), the first gear (20) having a radius r_{gear1} , the second gear (30) having a radius r_{gear2} and the inner tube (2) having a radius $r_{\text{inner tube}}$ such that

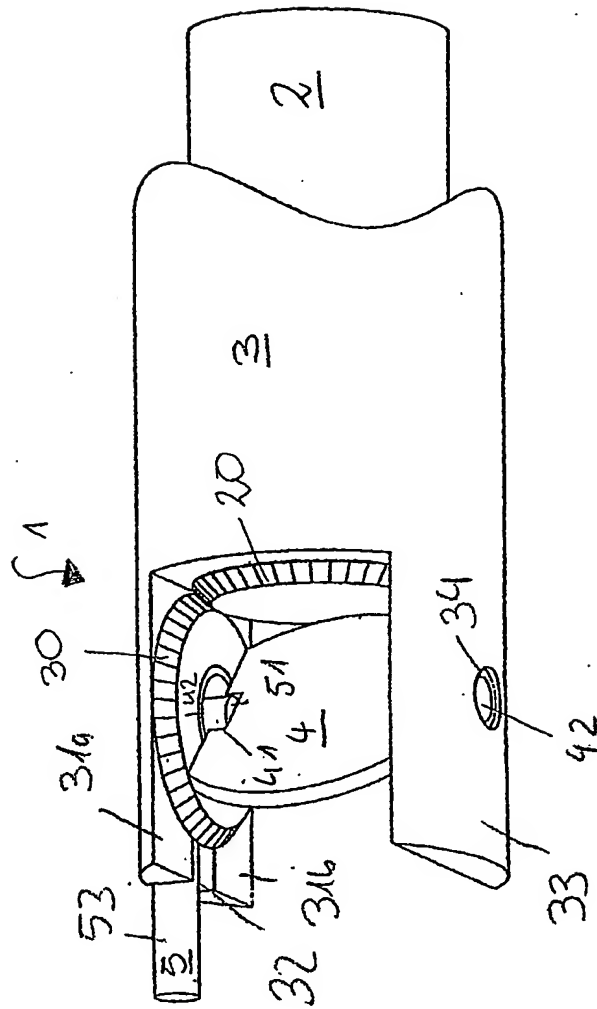
$$r_{\text{table}} \leq r_{\max} - d \sqrt{1 + \frac{1}{n^2}},$$
 with d being the gear thickness and n being the gear transmission ratio.
2. Sample device according to claim 1, characterized by
 - at least one first cable guide (5) having a first end (51) connected to the turntable (4) and the second end (53) connected to a cable support.
3. Sample device according to claim 2, characterized in that
 - the cable support is guided by the outer tube and/or connected to at least one synchronizing means and/or at least one first driving unit.
4. Sample device (1) suited to be inserted inside an external tube (10) with a radius r_{\max} , comprising
 - a turntable (4) with a substantially circular plate (40) having a radius r_{table} ,
 - a rotator for rotating said turntable (4) around two substantially orthogonal axes (11, 12),
 - at least one supporting means for supporting the turntable (4), and
 - at least one first cable guide (5) having a first end (51) connected to the turntable (4) and the second end (53) connected to a cable support, said cable support being connected to at least one first driving unit.

5. Sample device according to claim 4, characterized in that the supporting means comprises an outer tube (3).
6. Sample device according to claim 4 or 5, characterized in that an inner tube (2) is coaxially arranged within the outer tube (3), preferably at least one gear being arranged between the inner and the outer tube.
7. Sample device according to claim 6, characterized by two meshing gears (20, 30), the first gear (20) being connected to the inner tube (2) and the second gear (30) being connected to the turntable (4), preferably the first gear (20) having a radius r_{gear1} , the second gear (30) having a radius r_{gear2} and the inner tube (2) having a radius $r_{\text{inner tube}}$ such that $r_{\text{table}} \leq r_{\text{max}} - d \sqrt{1 + \frac{1}{n^2}}$, with d being the gear thickness and n being the gear transmission ratio.
8. Sample device according to one of the claims 4 to 7, characterized in that the cable support is guided by the supporting means, in particular the outer tube, and/or connected to at least one synchronizing means.
9. Sample device according to one of the preceding claims, characterized in that the gear thickness d is the thickness of the first or second gear, preferably corresponding to the thickness of the inner tube.
10. Sample device according to one of the preceding claims, characterized in that the gear transmission ratio n corresponds to $r_{\text{inner tube}} / r_{\text{gear}}$, with $r_{\text{gear}} = r_{\text{gear1}}$ or r_{gear2} , preferably $r_{\text{gear1}} = r_{\text{gear2}}$ and/or $r_{\text{gear1}} = r_{\text{inner tube}}$.
11. Sample device according to one of the claims 2 to 10, characterized in that the first cable guide (5) comprises at least one first bellow (52) and/or spring, preferably between the two ends (51, 53), in particular the first end (51) being arranged substantially perpendicular to the second end (53).
12. Sample device according to claim 11, characterized in that the first bellow and/or spring is guided by a support, preferably connected with the outer tube.

13. Sample device according to one of the claims 2 to 12, characterized in that the cable support is provided with at least one external second bellow and/or spring.
14. Sample device according to one of the preceding claims, characterized in that the inner tube and/or the outer tube is/are connected to at least one second driving unit.
15. Sample device according to one of the preceding claims, characterized in that the rotator comprises the inner tube (2), the outer tube (3) and/or the cable guide (5) connected to at least one driving unit, in particular the first and/or second driving unit(s).
16. Sample device according to one of the claims 3 to 15, characterized in that the driving unit, in particular the first and/or second driving unit(s), comprises at least one stepper engine and/or at least one worm wheel and/or at least one gear.
17. Sample device according to one of the preceding claims, characterized in that the outer tube (3) is provided with at least one axial extension (31a, 31b, 33) for supporting the turntable (4).
18. Sample device according to claim 17, characterized in that the extension (31a, 31b, 33) is provided with at least one recess (32, 34) for carrying at least one first bearing (62, 63) and/or the cable guide (5), the turntable (4), in particular a rotation pin (42, 43) connected to the substantially circular plate (40), and/or the cable guide (51, 52) is/are mounted within at least one first bearing (62, 63).
19. Sample device according to claim 17 or 18, characterized in that the outer tube (3) is provided with two opposite extensions (31a, 31b, 33) for carrying at least two rotation pins (42, 43).
20. Sample device according to one of the preceding claims, characterized by a second bearing (61) between the inner tube (2) and the outer tube (3).
21. Sample device according to one of the preceding claims, characterized in that the first and second gears are formed as tooth or roll gears, and/or the first and second gears are formed as straight and/or conical gears.

22. Sample device according to one of the preceding claims, characterized in that the first gear (20) is machined on or mounted on the inner tube (2), and/or the second gear (30) is machined on or mounted on the turntable (4), in particular a support (44) extending substantially perpendicular to the plate (40) and/or substantially coaxially to at least one rotation pin (42, 43).
23. Sample device according to one of the preceding claims, characterized in that the inner tube is made from carbon fiber and/or provided with chrome plated teeth, and/or the turntable is made from carbon fiber and/or provided with chrome plated teeth.
24. Sample device according to one of the preceding claims, characterized in that the first and/or second gear is/are made of acetal.
25. Sample device according to one of the claims 9 to 24, characterized in that the first and/or second bellow is/are made out of rubber, and/or the first and/or second spring is/are made out of non magnetic metal, preferably comprising copper, like copper beryllium, or plastic.
26. Sample device according to one of the preceding claims, characterized by at least one thermal isolation layer between the external tube and the outer tube, the thermal isolation layer preferably being evacuated.
27. Sample device according to one of the preceding claims, characterized by means for blowing a gas, in particular conditioned air, into the external tube, preferably the gas entering into the inner or outer tube and exiting the outer or inner tube.
28. Sample device according to one of the preceding claims, characterized by a control unit connected to the first and/or second driving unit.
29. Sample device according to one of the preceding claims, characterized in that at least one test object, at least one sample, at least one sensor, at least one mirror, at least one camera, at least one tool and/or at least one electronic device is/are, preferably detachably, attached to the turntable, in particular at least one side of the substantially circular plate, and/or connected with the control unit.

30. Sample device according to claim 28 or 29, characterized in that the control unit is arranged remote from the turntable, preferably at least one cable, in particular guided at least partially within the first cable guide, being provided between the control unit and the turntable.
31. Sample device according to one of the preceding claims, characterized by at least one second cable guide, preferably connected to the second end of the first cable guide, in particular being substantially flat and/or flexible.
32. Sample device according to one of the claims 29 to 31, characterized in that the sensor comprises at least one coil and/or at least one magnetic sensor, in particular for providing a magnetic calibration device.
33. Sample device according to one of the claims 29 to 32, characterized by a source for emitting, preferably electromagnetic, radiation, in particular comprising a laser and/or a visible light source.
34. Sample device according to claim 33, characterized in that the radiation is guided to the turntable, in particular to the mirror and/or camera, preferably within the inner tube, in particular via at least one glass and/or fiber-optic light guide or waveguide.
35. Sample device according to one of the preceding claims, characterized in that the amount of turns of the inner tube differs from the amount of the turns of the outer tube by one turn within one cycle, in particular measuring or calibration cycle.



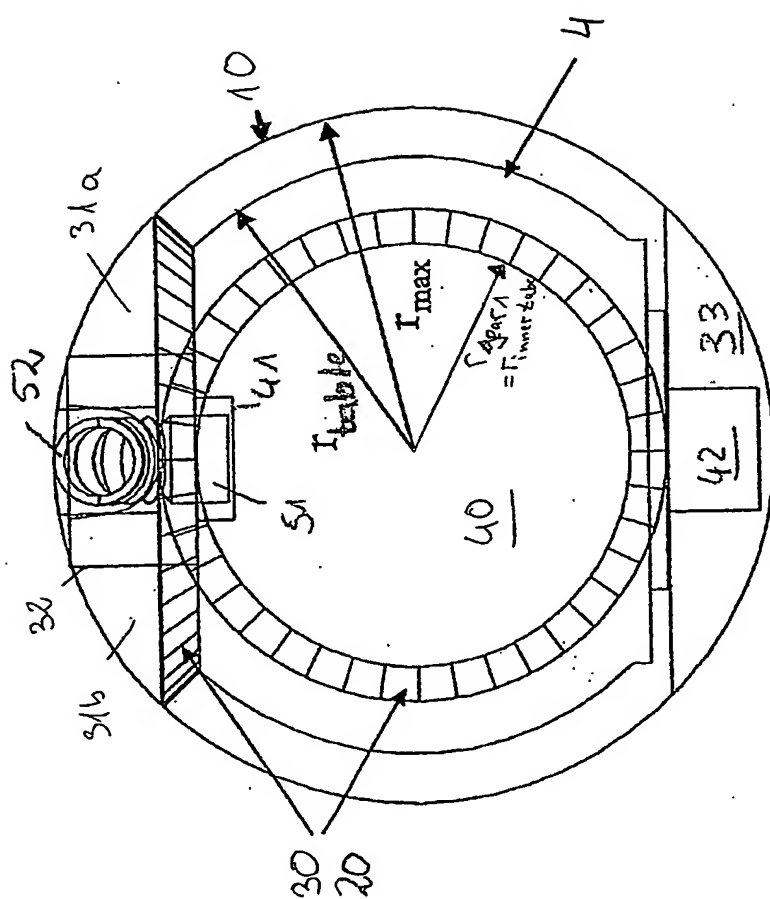


Fig. 2

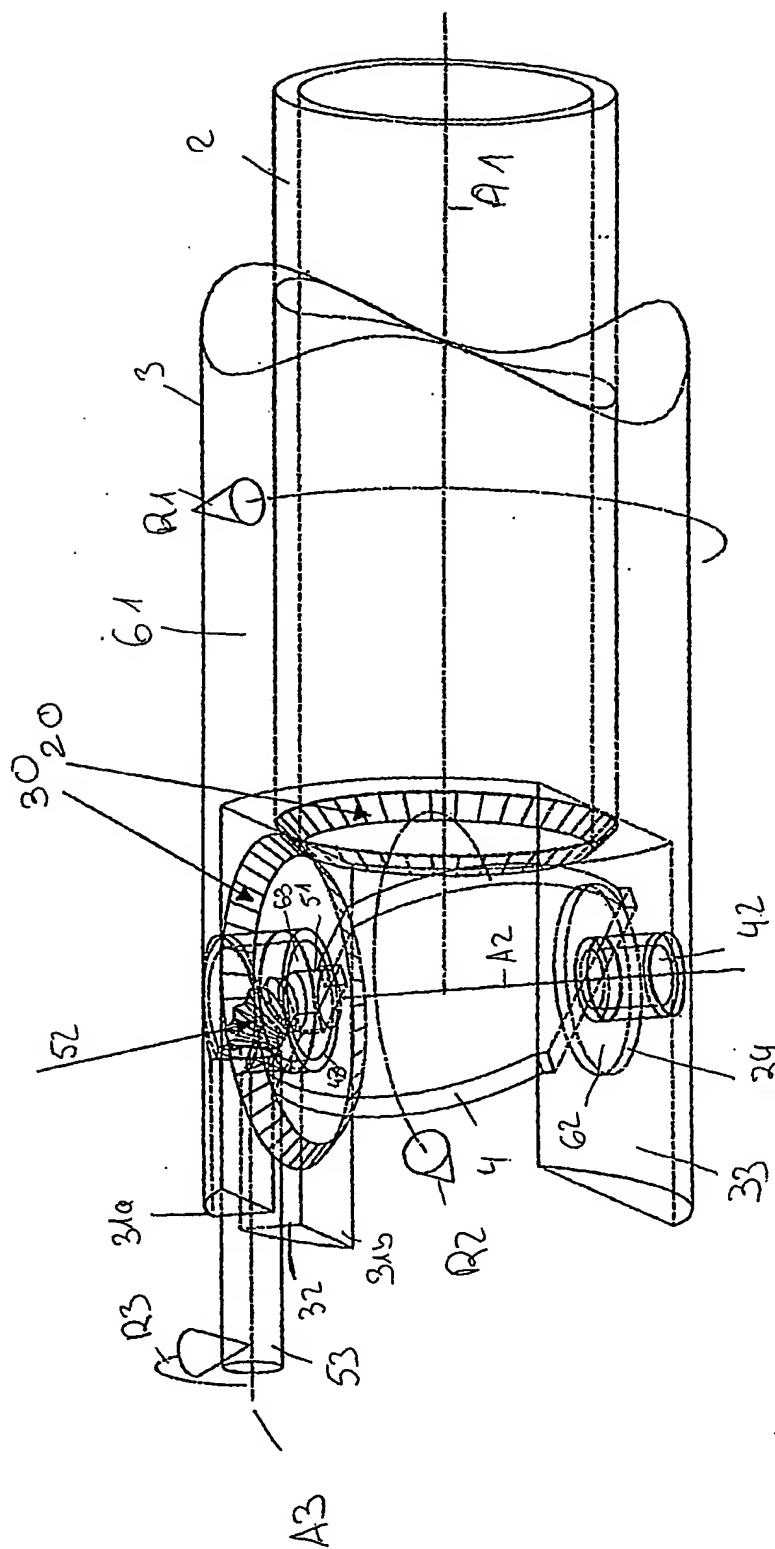


Fig. 3

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/EP 03/14965

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F16M11/12 F16M11/18 G01R35/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F16M G01R H01J B25J F16H G02B B23Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR 2 704 050 A (GIAT IND SA) 21 October 1994 (1994-10-21) page 7, line 27 - page 9, line 24; figures 2,7a,7b	1,4
A	DE 44 31.494 A (SUHM PHILIPP DIPL INFORM) 28 March 1996 (1996-03-28) the whole document	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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